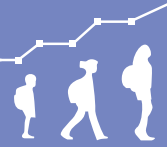


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*Making a  
Difference?*

The Effects of  
Teach for America  
in High School

ZEYU XU,  
JANE HANNAWAY,  
AND COLIN TAYLOR

## **Making a Difference?: The Effects of Teach for America in High School**

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Teach for America (TFA) recruits and selects graduates from some of the most selective colleges and universities across the country to teach in the nation's most challenging K-12 schools throughout the nation. TFA has grown significantly since its inception in 1990, when it received 2,500 applicants and selected and placed 500 teachers. In 2005, it received over 17,000 applicants and selected and placed a little over 2,000 new teachers, and the program anticipates expanding to over 4,000 placements in 2010. In total, the program has affected the lives of nearly 3 million students.

The growth of the program alone suggests that TFA is helping to address the crucial need to staff the nation's schools, a particularly acute need in high poverty schools, but TFA is not without its critics. The criticisms tend to fall into two categories. The first is that most TFA teachers have not received traditional teacher training and therefore are not as prepared for the demands of the classroom as traditionally trained teachers. TFA corps members participate in an intensive five-week summer national institute and a two week local orientation/induction program prior to their first teaching assignment.<sup>2</sup> The second criticism is that TFA requires only a two year teaching commitment, and the majority of corps members leave at the end of that commitment. The short tenure of TFA teachers is troubling because research shows that new teachers are generally less effective than more experienced teachers (Rivkin, Hanushek, and Kain, 2005; Rockoff, 2004).

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<sup>2</sup> In recent years, TFA corps members have also engaged in on-going professional development activities provided by TFA and whatever other supports school districts provide new teachers.

The research reported here investigates the relative effectiveness (in terms of student tested achievement) of TFA teachers, and examines the validity of the criticisms of TFA. Specifically, we look at TFA teachers in secondary schools, and especially in math and science, where considerable program growth is planned over the next few years. To the best of our knowledge, this is the first study of TFA at the secondary school level.

Using individual level student data linked to teacher data in North Carolina, we estimate the effects of having a TFA teacher compared to a traditional teacher on student performance. The North Carolina data we employ are uniquely suited for this type of analysis because it includes end of course (EOC) testing for students across multiple subjects. This allows us to employ statistical methods that attempt to account for the nonrandom nature of student assignments to classes/teachers, which have been shown to lead to biased estimates of the impact of teacher credentials (Clotfelter, Ladd, and Vigdor, 2007a; Goldhaber, 2007).

The findings show that TFA teachers are more effective, as measured by student exam performance, than traditional teachers. Moreover, they suggest that the TFA effect, at least in the grades and subjects investigated, exceeds the impact of additional years of experience, implying that TFA teachers are more effective than experienced secondary school teachers. The positive TFA results are robust across subject areas, but are particularly strong for math and science classes.

## **Previous Research**

Research examining the impact of TFA teachers on student performance is surprisingly sparse given its rapid expansion and the given the attention that the program has received from the education policy community, college students, and school districts serving low income communities.

We found no research on TFA at the secondary school level. Most work has focused on elementary school teachers and some on middle school teachers. The most prominent study is the random assignment study conducted by Mathematica (Decker, Mayer and Glazerman, 2004). The Mathematica study compares student achievement outcomes among students taught by TFA teachers and other teachers in the same schools and at the same grade levels. The control group tended to be diverse; some teachers were certified and some were not. Because the control group teachers are the set of teachers who would have likely taught the students in the absence of TFA, they are arguably the appropriate comparison group for policy purposes. Students were randomly assigned to teachers prior to the beginning of the school year to ensure there were no systematic differences between the student groups at the outset of the study. Both TFA and traditional teachers in the study were in self-contained classrooms in grade 1 through grade 5. Student outcomes were assessed on the basis of math and reading tests that were administered at the beginning and end of the academic year.

The Mathematica study found that TFA teachers outperformed the control teachers, including experienced teachers, in student math achievement. The impact of

TFA teachers and control teachers was no different in reading achievement. When TFA teachers were compared with novice control teachers, the impact on math achievement was larger than when compared to the full teacher control group, and reading remained insignificant.

Two recent studies estimated TFA effects on student performance using large scale data from New York City. Both focused on reading and math performance of students in grades 4 through 8; both differentiated non-TFA teachers into multiple categories of teachers (e.g., in terms of certification); and both explicitly took experience into account.<sup>3</sup>

Kane, Rockoff, and Staiger (2006) used six years of data and found a small positive effect for TFA on student math achievement (.02 standard deviations) relative to certified teachers, controlling for years of teaching experience. The effect was somewhat smaller for elementary school teachers (.015) and larger for middle school teachers (.027). They also found that the returns to experience were greater for TFA teachers than traditionally certified teachers, though not statistically significant. The experience differentials overall were small such that even a small difference in effectiveness may offset turnover. Similar to the Mathematica study, there were no differences in reading. In general, they found that the certification status of a teacher has at most a small impact on

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<sup>3</sup> Two smaller studies of TFA were also conducted with data from Houston (Raymond, Fletcher and Luque, 2001); (Darling-Hammond, Holtzman, Gatlin and Heilig, 2005), but they are not as rigorous as the New York City studies. Both found positive effects for TFA in math on the state test, though the second study found negative effects on other subjects and tests. The first study compared TFA teachers to other teachers in the district; the second study compared TFA teachers holding standard certification.

student performance; and variation in teacher effectiveness within certification categories was large.

Boyd, Grossman, Lankford, Loeb, and Wyckoff (2006) compared the performance of teachers entering teaching in New York City from different pathways, including TFA. They had one year less of data so they work with a smaller sample of TFA teachers than Kane, Rockoff and Staiger (2006). They also distinguish two types of certification status: “college recommended” and individual evaluation. The former refers to teachers who fulfilled certification requirements at a university-based program registered with the state. The latter refers to teachers who fulfilled their requirements at different institutions, including through distance learning.

The Boyd, Grossman, Lankford, Loeb and Wyckoff study compares pathway effects relative to college recommended teachers. They found differences by grade level and subject. In ELA (English/Language Arts), TFA teachers perform somewhat worse than ‘college recommended’ teachers in their first year teaching, though they tend to catch up to some degree in later years. In middle school math, however, TFA teachers had an advantage right off in their first year teaching. The finding was statistically significant across a number of specifications. Similar to the other New York City study, this study also found that the variation in teacher effectiveness within pathways was greater than the average difference between pathways.<sup>4</sup>

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<sup>4</sup> While not directly an examination of TFA, a recent study by Boyd, Lankford, Loeb, Rockoff, and Wyckoff (2007) found a substantial narrowing of the gap in teacher qualifications between schools serving disadvantaged and schools serving more affluent students in New York City between 2000 and 2005. They credit the converging of qualifications to three policy changes: (1) abolishing temporary licenses for

This study focuses on TFA effects in high school, where teacher academic qualifications are particularly important (Goldhaber and Brewer, 2000). Four sections follow. We first describe the data and the variables used in the analysis. The next section discusses the analytic strategy we employ followed by a presentation of results. The final section discusses the implications for policy and practice.

## **Data**

We focus our analysis on North Carolina because of the rich administrative databases available through the North Carolina Education Research Data Center (NCERDC) at Duke University. Since the late 1990s, the state of North Carolina has required schools to administer subject-specific End-of-Course (EOC) exams during the last two weeks of the school year.<sup>5</sup> We estimate the effect of Teach for America teachers relative to traditional-route teachers on student achievement in high school using EOC exam outcomes.

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uncertified teachers; (2) the creation of alternative certification routes; (3) and the creation of the Teacher Fellows Program. The newly hired teachers—TFA and Teaching Fellows—represented 40 percent of all new hires in 2005. On average they have higher test scores and stronger academic backgrounds than other teachers and, by design, are placed disproportionately in high poverty schools where temporarily licensed teachers tended to teach previously. The improved teacher qualifications for the schools serving the most disadvantaged students led to improved student performance between 2000 and 2005. The improvement more than half offset any deficit associated with being a first year teacher. As with other studies, the effects in math were stronger than the effects in ELA. In short, the findings show that recruitment strategies that target teachers with strong academic credentials, like Teach for America, can substantially change outcomes for students.

<sup>5</sup> Subjects tested are Algebra, Algebra II, Geometry, Biology, Chemistry, Physics, Physical Science, English I, US History, Civics and Economics and Occupational Course of Study. We do not include US History, Civics and Economics, or Occupational Course of Study because data for those tests are not available in all years. See Exhibit 1 for a list of courses that require EOC testing.



NCERDC collects data from the North Carolina Department of Public Instruction (NCDPI) at the end of each school year and compiles the data into annual datasets at the student, teacher, classroom,<sup>6</sup> and school levels. Student data contain information on ethnicity, gender, exceptionality status, grade level, district and school code, survey data on parent education and homework habits, and scale score achievement levels for any EOC exams taken by a student in a given year.<sup>7</sup> Teacher data include salary, experience, licensure, educational attainment, PRAXIS test scores, and National Board Certification. Teach for America staff helped us construct a separate dataset showing Teach for America corps members, which NCERDC later linked to their teacher data using social security numbers. Finally, the classroom data contain records for each activity that occurred in a North Carolina public school in a year. Records list course title, section number, semester, subject, grade level, student ethnicity and gender counts, and teacher experience, ethnicity and gender.

We limit our data to the 2000–01 through 2006–07 school years, the years of data available during which Teach for America corps members were teaching in North Carolina. We further limit our sample to the 23 LEAs that hired at least one TFA teacher at any point during this time period. Then we merge each annual student dataset into a

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<sup>6</sup> NCERDC calls classroom-level data School Activity Reports.

<sup>7</sup> Some students had multiple records in a year with different EOC scores in each record. All observations for that student in that year were dropped. A very small number of students (less than 0.5 percent) had multiple valid scores on the same subject in one year, mostly a result of school change during the school year. An even smaller number of students (about 0.05 percent) had two identical scores on the same subject in one year with identical teachers associated with the scores. In both of these cases, we dropped those observations. On the other hand, some students took the same EOC subject exam multiple times throughout their high school years; in most cases, they had failed to reach the “proficient” level in earlier attempts. These cases account for five percent of all EOC students. Since repeated testing on the same subject may be a confounding factor in our estimation of teacher effect on student performance, our analysis focuses on first-time test takers only.

student longitudinal file. We apply the same method to the teacher and classroom data, so that we have three longitudinal files, one each at the student, teacher and classroom levels.

To estimate the effect of a teacher on her students' testing outcomes, we must link students to their classroom instructor for the relevant EOC exam. This presents a challenge in North Carolina. The student data identify the proctor of each student's EOC exam, but the proctor is not necessarily the instructor for that student's class. In Goldhaber and Anthony (2004), the authors cite North Carolina state officials who say that at least 90 percent of the time, the students' proctor is the same person as the actual classroom teacher. They verify this information by contacting 20 large school districts and find that the proctor matches the students' classroom teacher 80 percent of the time at the elementary level. At the high school level, in Clotfelter, Ladd, and Vigdor (2007a), the authors link classroom data to the student data using the classroom instructor code and the student exam proctor code and verify those matches using a fit statistic based on classroom demographics. They found a match in about 70 to 75 percent of the cases. Given the success of this method, we apply a matching and verification method similar to that used in Clotfelter, Ladd, and Vigdor (2007a), as described below.

First, individual students on the EOC file were aggregated into test classrooms by district and school code, year, test proctor, subject and class period. Each resulting record is associated with one proctor and lists classroom-level demographic, exceptionality and grade level information. Next, we turn to the actual classroom data. We keep only course

descriptors requiring EOC assessments as stipulated by the North Carolina Department of Public Instruction (exhibit 1) and collapse records for the same course meeting that differ only on the semester variable into one record per year.<sup>8</sup> With both the EOC and classroom data aggregated into unique classroom-by-year-by-subject records, they can be matched. To do so, we link all exam classrooms in a school/year with all course activities related to the test subject in that school for that school year. Then we verify the matches using the teacher ID variable and a fit statistic similar to the one used by Clotfelter, Ladd and Vigdor (2007a). This statistic measures the expected squared deviations of total classroom membership count, number of white students, and number of male students between test classrooms and actual instructional classrooms.

We go through a number of steps to verify possible matches. First, we consider those classes matched by uniquely identifiable teacher ID. If more than one exam classroom match occurred for an actual classroom teacher in the same section, course, school and year, we kept the match with the lowest fit statistic (thus closer resemblance between the exam and actual classrooms). Among these retained matches, cases where the fit statistic is greater than or equal to 1.5 are deemed unreliable and hence discarded. The remaining cases are considered “good” matches with reasonable confidence. They constitute our first classroom/teacher sub-sample (sample A).

With those matches set aside, we use the fit statistic to verify classroom matches within school, year and subject that do not match on teacher ID. The general idea is that,

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<sup>8</sup> Course activities in the classroom data are unique by district and school code, teacher code, year, subject, course number, and section number. These records are repeated for each semester or quarter of the course.

when an EOC exam is administered by a teacher other than the classroom instructor, if the test classroom sufficiently resembles the instruction classroom in terms of student demographic compositions, a classroom instructor can be reliably assigned to that group of students. The success of this strategy relies on the number of test classrooms within a school-year-subject combination and how distinctive they are. In our high school data set, the median number of test classrooms within each school, year, and subject is 6, and they appear to be sufficiently different from each other to be distinguished by demographic distributions. For each unique actual instructional classroom, we kept the test classroom that matched with the lowest fit statistic. Even after identifying the best match, if the fit statistic was equal to or greater than 1.5, we dropped that classroom. The remaining matches constitute our second classroom/teacher sub-sample (sample B). We then combine those classrooms matched by teacher code and verified with those matched using only the fit statistic. In this dataset, if a test proctor matched two actual classrooms, we kept the match with the lower fit statistic.

Once classroom instructors are identified, we attach them back to the student-level test data and match teacher data to the actual classroom instructor. Using this method, we are able to match about 84 percent of students to their teachers. For the purpose of model estimation, we use two alternative analytical samples to ensure estimated TFA effects are robust to matching methods. The first sample includes all teachers who are either matched on their ID and verified or matched by class demographic variables only. As we are less confident with cases where proctors and

instructors are matched solely on the basis of class demographics, the second sample includes only those teachers who are matched on ID and verified by class demographics.

### **Analytic Strategy**

A key challenge to the estimation of TFA teacher effects is possible non-random sorting of teachers and students both across and within schools. Evidence has shown a matching between observed teacher qualifications (such as years of experience) and student achievement, possibly as a result of teacher preference and parent pressure (Clotfelter, Ladd, and Vigdor, 2007a). When both teacher quality and student performance are systematically related to student ability and motivation, the relationship between teacher and student performance cannot be reliably estimated. In this particular study, if TFA teachers are assigned to students with greater needs, estimated TFA effects are likely to be downwardly biased; on the other hand, if TFA teachers are systematically assigned to less challenging classes, OLS estimates of TFA effects are likely to be biased upwardly.

To mitigate such potential biases resulting from non-random matching of teachers to students, student fixed-effects models are typically used when longitudinal data are available. These models take advantage of repeated student performance measures over time, and identify teacher effects using within-student variation of teacher inputs:

$$(1) y_{it} = \beta_0 + X_{it}\beta + c_i + u_{it}$$

$y_{it}$  represents student  $i$ 's test score in year  $t$ , and  $X$  is a vector of individual, family, and teacher characteristics. In this model, the residual term includes two components: a time-constant component  $c_i$ , and a "usual" residual component  $u_{it}$  that is homoskedastic,

uncorrelated with any independent variables or  $c_i$ , and not autocorrelated.  $c_i$  captures any student characteristics that are fixed over time, both observed (such as gender and race/ethnicity) and unobserved characteristics (such as ability and academic orientation) that may be related to teacher sorting. Since these characteristics are constant for each student over time, they drop out of the equation by demeaning equation 1. In this way, the confounding factors of non-random teacher-student sorting are removed, and teacher effects can be consistently estimated.

In our high school analysis, however, we do not have repeated measures of student performance in a particular subject over time. Most often, students take a subject, such as Algebra I, once. As a result, this study adopts an ingenious fixed-effects model used by Clotfelter, Ladd, and Vigdor (2007a) given the rich nature of the North Carolina data. Instead of using within-student variation *over time*, the model takes advantage of within-student variation *across subjects* that are evaluated by end-of-course exams in North Carolina.<sup>9</sup>

$$(2) y_{ij} = \beta_0 + T_{ij}\beta + c_i + u_{ij}$$

The subscript  $j$  denotes EOC subjects.  $T_{ij}$  represents student  $i$ 's teacher in subject  $j$ . The key variable of interest in this vector is a TFA indicator variable that equals to 1 if the teacher is affiliated with the TFA program and 0 otherwise.  $T_{ij}$  can also include other teacher qualification variables such as teacher experience as well as classroom variables. Analogous to a standard student fixed-effects model,  $c_i$  captures student characteristics

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<sup>9</sup> Dee and Cohodes (2008) use a similar strategy with the National Education Longitudinal Study of 1988 (NELS: 88).

such as unobserved ability that are constant across test subjects. Although it may be reasonable to assume general student ability to be relatively stable over time, whether or not student ability captured by this error term is constant across subjects needs to be verified. If  $c_{ij} = c_i$  for all  $j$ , the fixed-effects transformed equation of this cross-subject model is:

$$(3) \ y_{ij} - \bar{y}_i = (T_{ij} - \bar{T}_i)\beta + u_{ij} - \bar{u}_i$$

where variables with a superscript bar denote student-specific means across subjects and  $c_i$  is removed from the equation.

As should be clear, whether or not the student-specific error term varies by subject is key to the validity of cross-subject fixed-effects models. If the assignment of TFA teachers is based on subject-specific student ability that is multi-dimensional, the non-random matching of teachers to students remains unaccounted for in these fixed-effects models.

Using the same North Carolina high school data, Coltfelter, Ladd and Vigdor (2007a) investigate this crucial question in great detail. Their investigation concludes that in North Carolina high schools, student ability varies little by subject (with slightly larger difference between English and other math and science-related subjects); when schools assign students to classrooms, they appear to consider student ability to be “single dimensional”. For further assurance, we conducted a direct examination of the eight core EOC subjects using principal component analysis. The results show that all tests are loaded predominantly on one single underlying dimension, lending further support to the

assumption that students performing well in one subject are also likely to perform well in other subjects, and that any teacher-student sorting based on the ability in one subject probably will follow similar patterns if such sorting were based on student ability in any other subjects. (See figure 1.)

The lack of an initial student performance measure in a specific subject has another important implication for our cross-subject student fixed-effects model. Since education is a cumulative process, academic performance depends not only on contemporaneous inputs but also on inputs from all previous time periods. Levels of academic performance at the beginning of the current time period capture students' cumulative education experiences up until that point. As a result, value-added models are typically used to estimate teacher effects on student performance. Without initial test scores for high school EOC subjects, we are not able to specify a model that controls for lagged student performance on the right hand side of the equation (or the construction of a gain score).

In effect, our model without pre-test information assumes complete “decay” of prior input; that is, initial academic preparation in a specific subject at the time of class enrollment has negligible effect on EOC test scores. What the cross-subject model does account for is the overall level of performance across eight subjects. Clotfelter, Ladd, and Vigdor (2007b) argue that a model with a missing lagged term leads to downward bias in estimates, and that the less the decay, the larger the downward bias.<sup>10</sup> The TFA effect

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<sup>10</sup> The authors acknowledge the insights from Rivkin (2006) and Hanushek, Kain and Rivkin (2006) as the basis of this observation.



estimated using the cross-subject model, therefore, is likely to provide the lower bound of the true effects.

### **Variables and Model Specification**

The North Carolina Department of Public Instruction requires students taking certain high school courses for credit to take End-of-Course (EOC) tests on multiple subjects, including eight core subjects requiring testing for the entire span of years in our dataset (Algebra I, Algebra II, Geometry, Physical Sciences, Physics, Chemistry, Biology, and English I)<sup>11</sup>. Our dependent variable is standardized EOC test scores in these eight subjects. The scores are standardized by subject and year, with mean 0 and standard deviation 1. By this transformation, scores from different tests are put on the same scale. It is important to note, however, that these standardized test scores represent each student's performance relative to all other test-takers in the same year and subject across the 23 LEAs under study.

Our key independent variable is a TFA indicator variable. Control variables include teacher experience, gender, race/ethnicity, and education attainment. We also include class size and peer average performance on 8<sup>th</sup>-grade math and reading (from North Carolina's "End-of-Grade" exams that are administered to elementary and middle-school students) to control for classroom environment. All models are estimated with student fixed-effects as well as subject-by-grade and year fixed-effects.

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<sup>11</sup> Not all eight subjects were tested in year 2006-07. Chemistry, Physics and Physical science were excluded in 2006-07 as the test for these three subjects were changed in that year and were administered to select samples for field-testing. The revised tests are planned to be implemented statewide in 2007-08.

This study focuses on the overall effectiveness of TFA teachers as compared to non-TFA teachers. Such relative effectiveness may be the result of a couple of factors, such as differences in academic preparation in a subject area and in pedagogical training. However, because the key research question of this study is whether or not the TFA program can provide effective teachers to supplement the existing teaching force, our model does not include variables such as the selectivity of higher education institutions attended by teachers or license test scores. Descriptive comparisons do show, however, that disparities do exist between TFA and non-TFA teachers in terms of their academic preparation.

## **Results**

Tables 1–3 present comparisons of TFA teachers with all non-TFA teachers as well as novice non-TFA teachers in the 23 LEAs under study. Novice teachers are defined as teachers with less than three years of experience.

Compared with non-TFA teachers and novice non-TFA teachers, a smaller percent of TFA teachers are from race/ethnic minority groups (table 1). About 13 percent of TFA teachers are non-White, compared with about 25 percent and 26 percent minorities among all non-TFA teachers and novice non-TFA teachers respectively. TFA teachers are typically new college graduates. As a result only 2 percent of them have a Master’s degree or higher. By contrast, 31 percent of all non-TFA teachers and 18 percent of novice non-TFA teachers have a graduate degree. However, significantly more TFA teachers have graduated from “most selective” or “very selective” higher education

institutions than non-TFA teachers do (62 percent versus 22 percent). TFA teachers also have higher PRAXIS scores on average than non-TFA teachers (about 0.4 standard deviations higher). Finally, higher percentages of TFA teachers are licensed in the subject area they teach than non-TFA teachers (88 percent versus 84 percent in science subjects, 73 percent versus 72 percent in math subjects, and 92 percent versus 70 percent in English).

TFA and non-TFA teachers are also assigned to classrooms and students with distinct characteristics and performance levels. Classes taught by TFA teachers on average have much higher minority concentrations (about 81 percent) as compared to those taught by non-TFA teachers (48 percent for all non-TFA teachers and 53 percent for novice non-TFA teachers). (See table 2.) In general, TFA teachers are assigned to more academically challenged classrooms. Using achievement levels defined by the North Carolina Department of Public Instruction, table 2 shows that lower percentages of students in classrooms taught by TFA teachers have achieved a “superior performance” or “consistent mastery” rating in all subject areas. The contrast is more striking if we look at the “superior performance” level only. Classes of non-TFA teachers have at least twice as many students performing at this highest level in terms of percentage than classes of TFA teachers. Classes of novice non-TFA teachers perform at somewhat lower levels compared to those taught by more experience non-TFA teachers, but they are still performing at significantly higher levels than classes of TFA teachers.

Similar patterns emerge when we compare TFA and non-TFA teachers at the student level (table 3). Students of TFA teachers are more likely to be race/ethnic minorities, less likely to have parents with Bachelor's degrees or higher, and have lower standardized scale scores on EOC assessments across all subjects. Students of novice non-TFA teachers have lower average scores than those taught by more experienced non-TFA teachers, but they still have clear advantage over students of TFA teachers.

In short, TFA teachers differ significantly from non-TFA teachers (both novice and overall) in terms of their demographic characteristics, academic preparation, experience, as well as the classes and students they teach. Such patterns are consistent with findings from earlier studies on TFA teachers using data from different states. The TFA program selects graduates from the most competitive undergraduate institutions and places them as teachers in the lowest-performing schools in the country. And TFA teachers are placed in the most demanding classrooms in these already challenging schools.

Such non-random assignment of TFA teachers to classrooms and students needs to be accounted for before reliable TFA effects can be estimated. Using the analytic strategy discussed in the previous section, student fixed-effects models are estimated. Results are presented in tables 4, 5 and 6. Each table shows two models, one without classroom variables and the other with controls for those variables. All standard errors are robust estimates that adjust for the clustering of students within teachers. Table 4 uses all eight EOC subjects. Because humanities may follow a somewhat different path than the

development of math and science skills, table 5 and 6 examine math subjects and science subjects separately.<sup>12</sup>

The effect of having a TFA teacher as compared to having a non-TFA teacher on high school student performance is stable and consistent across models and specifications, although TFA effects for science subjects tend to be larger than those for all subjects and for math subjects only. With all 8 subjects examined together without controlling for classroom variables, we find that having a TFA teacher is associated with about 0.10 standard deviations improvement in EOC performance as compared with having a non-TFA teacher. The effects of TFA teachers over non-TFA teachers for math and science subjects are 0.10 and 0.18 respectively. The TFA effects are about twice the effect of having a teacher with 3 years or more experience relative to having a novice teacher. Evidence shows that, in terms of test scores, TFA teachers are able to more than offset their lack of teaching experience, either due to their better academic preparation in particular subject areas or due to other unmeasured factors such as motivation. Consistent with the literature, our estimates show that the first three years of teaching experience makes a significant difference in teacher effectiveness, but the experience effect diminishes after that point.

Adding classroom variables does not appreciably change the estimated TFA effects, nor does it change the effect of having three to five years of experience.

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<sup>12</sup> We are able to estimate TFA effects for math and science teachers because scores from multiple EOC tests in each subject area are available (Algebra I, Algebra II, and Geometry for math, and Physical Science, Biology, Chemistry, and Physics for science). By comparison, we are not able to estimate TFA effects for English teachers only, as we only have English I test scores and hence there is no cross-subject variation that we can exploit to estimate cross-subject fixed-effects models.

However, teachers with six or more years of experience have less advantage over novice teachers than teachers with three to five years of experience in these models. One possible explanation is that it may be easier for more experienced teachers to choose high-performing classes to teach, as shown in descriptive table 2. As a result, after class size and average student performance are controlled for, the estimated effects of these teachers are reduced more than that of their colleagues.

Because we do not have additional information to verify the validity of those student-teacher matches where test proctor IDs and instructor IDs do not match and where the student-teacher link is established solely on the basis of classroom demographic distributions, we are not able to evaluate the scope of possible mismatches between students and teachers in those cases and its impact on model estimates.<sup>13</sup> In order to check the sensitivity of estimated TFA effects to our teacher-student linking methods, we re-estimate our models by excluding those cases. These results are presented in table 7. Using only those students whose classroom teachers and test proctors have the same uniquely identifiable IDs, and whose instructional classrooms sufficiently resemble the test classrooms in terms of demographic characteristics, we find slightly stronger (and also statistically significant) positive TFA effects when all 8 subjects are included (0.14) as well as when only high school science subjects are analyzed (0.19). Similar to the results obtained when using larger samples, TFA effects remain about two to three times the effect of having three to five years of teaching experience. By comparison, the TFA

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<sup>13</sup> For the 2006-07 school year, NCERDC compiled a “course membership” file that provides direct link between students and their classroom instructors. This provides us with an opportunity to check the validity of our matching methods. We find that about 77 percent of our student-teacher matches (both methods) in 2006-07 are indeed correct matches.

effect on math subjects decreased, with its magnitude comparable to the effect of teacher experience (0.06) but statistically insignificant. This indicates that the estimated effect of having TFA teachers is somewhat sensitive to our teacher-student matching strategy for math test scores.

Next, we compare TFA teachers with non-TFA teachers with various qualifications in order to capture a more nuanced picture of the TFA effect. First, as shown in descriptive table 1, a disproportionately higher percentage of non-TFA teachers teach a subject outside of their license field than TFA teachers. We are interested in whether TFA teachers are as effective as those non-TFA teachers who are licensed in the subjects they teach. Table 8 compares all TFA teachers with non-TFA teachers certified in the subjects they teach. We find that the TFA effect remains the same as when we compare TFA teachers with all non-TFA teachers. TFA teachers retain an advantage of 0.11, 0.10 and 0.18 standard deviations over in-field non-TFA teachers in student performance across all EOC subjects, across math subjects, and across science subjects respectively.

Table 9 and 10 present comparisons of TFA teachers with non-TFA teachers holding two types of regular teaching licenses: the Standard Professional I license (SP I) and the Standard Professional/Continuing license (SP II). The SP I license is typically for teachers with less than 3 years of experience who have satisfied all state requirements for becoming a regular classroom teacher, whereas the SP II/Continuing license is given to teachers with more experience (see <http://www.dpi.state.nc.us/licensure/> for more

details). When compared with less experienced teachers with a regular teaching license, TFA teachers remain to be more effective across all subjects, for math subjects only and for science subjects only. TFA effects are stronger than those estimated when comparing with all non-TFA teachers. As expected, the TFA advantage is reduced when TFA teachers are compared with more experienced teachers holding SP II/Continuing licenses. The TFA effect falls to about 0.05 for all subjects and for math subjects only, and to about 0.13 for science subjects only. However, these effects remain much larger than the effect of teacher experience.

Table 11 further restricts the comparison sample to teachers who are licensed to teach in North Carolina through the traditional training track; that is, these are the teachers who are licensed by completing an approved teacher education program at an accredited North Carolina institution of higher education. The TFA effects estimated with this comparison group range from 0.08 to 0.16 and all remain significant (either at the .05 or .10 level).

In short, the TFA effect remains mostly consistent no matter what our comparison group is. TFA teachers have particular strong positive effects on student science test scores. In all cases, the TFA effect is several times larger than the effect of teacher experience.<sup>14</sup>

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<sup>14</sup> Not all TFA teachers were assigned to classes that require EOC tests. Therefore it is possible that only stronger TFA teachers were assigned to teach those higher-stake classes. We compared various teacher characteristics including PRAXIS scores of TFA teachers in the analytic sample and other TFA teachers. No significant difference was found between these two groups of TFA teachers.



Our final table examines the effect of TFA teachers from another perspective. We are interested in whether TFA teachers are particularly effective for certain types of students. We focus students' initial performance and divide them into quartiles (based on their 8<sup>th</sup>-grade math and reading scores). TFA effects are estimated for high-performing and low-performing students as well as students in the middle two performance quarters separately. Table 12 shows that having a TFA teacher is beneficial to all students regardless of their prior performance level. However, it seems that the TFA effect is the strongest for students in the top quarter of the performance distribution and the weakest for students in the bottom quarter of the performance distribution.

## **Discussion**

The research reported here is related to larger education policy and practice concerns about teacher quality, especially teacher quality for disadvantaged students. Teach for America taps into a non-traditional pool for teachers. The teachers TFA recruits and selects differ from traditional teachers, on average, in a number of ways. They tend to have stronger academic credentials; they have not been prepared in traditional teacher training programs; they are more likely to teach for only a few years; and they are assigned to the most challenging schools in the country. Given these differences, the program has been controversial. Research providing guidance on the merits of the program to policy makers and to local education administrators has been scant at the elementary school level and non-existent at the secondary school level. This study represents the first study at the secondary school level.

Our findings show that secondary school TFA teachers are more effective than the teachers who would otherwise be in the classroom in their stead. While these other teachers are a diverse group in terms of background and training, for policy purposes they are an appropriate comparison group. Other things being equal, the findings suggest that disadvantaged students taught by TFA teachers are better off than they would be in the absence of TFA.

But there are additional policy questions. Suppose we raised the bar on teacher qualifications and require that all secondary school teachers be fully licensed in their field, particularly teachers of math and science. Raising the bar may also mean we would have to raise salaries to attract sufficient numbers of qualified teachers. But under these conditions, would students be better or worse off with a TFA teacher? To examine this question we restricted the comparison to traditional teachers who were fully certified in field. The TFA advantage still held.

Or suppose we required that all teachers teaching disadvantaged secondary school students have, say, three years of prior experience. Would students be better or worse off with TFA teachers on average? The findings show that TFA status more than offsets any experience effects. Disadvantaged secondary students would be better off with TFA teachers, especially in math and science, than with fully licensed in-field teachers with three or more years of experience.

We should note that the findings here do not necessarily mean that there is no value to teacher training. It is possible that the teachers that TFA recruits and selects would be even more effective with more pedagogical training.

The findings have important implications for the recruitment and selection aspects of human resource management in education, at least for secondary school teachers. They stress the likely importance of strong academic backgrounds for secondary school teachers. They also suggest that policy makers should focus more on issues of teacher selection, and less on issues of teacher retention, if the concern is the performance of disadvantaged secondary school students especially in math and science. In short, they suggest that programs like TFA that focus on recruiting and selecting academically talented recent college graduates and placing them in schools serving disadvantaged students can help reduce the achievement gap, even if teachers stay in teaching only a few years.

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**Appendix**

Exhibit 1. Courses for credit that require End-of-Course assessments, by subject

| Name of course                          | End-of-course exam required |
|---|-----------------------------|
| English I                               | English I                   |
| Algebra I B                             | Algebra I                   |
| Algebra I<br>Integrated Math II         |                             |
| Geometry<br>Integrated Math III         | Geometry                    |
| Algebra II<br>Integrated Math III       | Algebra II                  |
| Biology<br>Biology II                   | Biology                     |
| Chemistry<br>Chemistry II               | Chemistry                   |
| Physical Science                        | Physical Science            |
| Physics<br>Physics II<br>IB Physics III | Physics                     |

Source: North Carolina Department of Public Instruction.

<http://www.ncpublicschools.org/docs/accountability/reporting/eoccreditcourses.pdf>

Retrieved on March 3, 2008

Figure 1. Screenplot of Eigen-values after principal component analysis of eight EOC assessment subjects

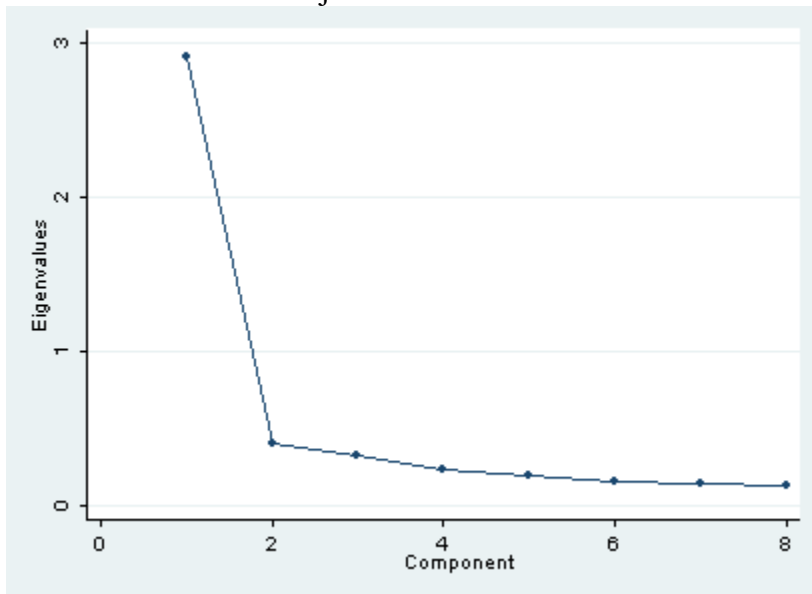


Table 1. Characteristics of TFA and traditional high school teachers in North Carolina school districts that accepted TFA teachers: Year 2000-01 through 2006-07

|   | TFA teacher |         | Traditional teacher |         | Novice Trad. teacher <sup>1</sup> |         |
|---|-------------|---------|---------------------|---------|-----------------------------------|---------|
|   | Mean        | Std Err | Mean                | Std Err | Mean                              | Std Err |
| Sex (percent)                             |             |         |                     |         |                                   |         |
| Female                                    | 65.31       | 4.30    | 69.00               | 0.39    | 68.81                             | 0.86    |
| Male                                      | 34.69       | 4.83    | 31.00               | 0.56    | 31.19                             | 0.95    |
| Race (percent)                            |             |         |                     |         |                                   |         |
| Black                                     | 6.12        | 2.43    | 21.98 *             | 0.50    | 22.27 *                           | 0.85    |
| Hispanic                                  | 1.02        | 1.02    | 0.85                | 0.11    | 1.17                              | 0.22    |
| White                                     | 86.74       | 3.44    | 75.17 *             | 0.52    | 74.35 *                           | 0.89    |
| Other                                     | 6.12        | 2.43    | 2.01                | 0.17    | 2.21                              | 0.30    |
| Overall teaching experience               | 0.17        | 0.04    | 8.63 *              | 0.12    | 0.57 *                            | 0.02    |
| Education attainment (percent)            |             |         |                     |         |                                   |         |
| Bachelor's                                | 97.96       | 1.44    | 68.70 *             | 0.57    | 81.99 *                           | 0.79    |
| Master's                                  | 2.04        | 1.44    | 29.52 *             | 0.56    | 17.72 *                           | 0.78    |
| Advanced/Doctorate                        | 0.00        | 0.00    | 1.76 *              | 0.16    | 0.29 *                            | 0.11    |
| Selectivity of IHE <sup>2</sup>           |             |         |                     |         |                                   |         |
| Most selective                            | 17.35       | 3.85    | 1.87 *              | 0.17    | 2.59 *                            | 0.32    |
| Very selective                            | 44.90       | 5.05    | 20.45 *             | 0.49    | 23.02 *                           | 0.86    |
| Moderately selective                      | 37.76       | 4.92    | 57.68 *             | 0.61    | 56.09 *                           | 1.01    |
| Not selective/not ranked                  | 0.00        | 0.00    | 20.00 *             | 0.49    | 18.31 *                           | 0.79    |
| License test score (PRAXIS) <sup>3</sup>  | 0.45        | 0.07    | 0.17 *              | 0.01    | 0.18 *                            | 0.02    |
| Licensed in subject taught <sup>4,5</sup> |             |         |                     |         |                                   |         |
| Science                                   | 88.16       | 3.73    | 84.22               | 0.46    | 81.74                             | 1.08    |
| Math                                      | 73.08       | 6.21    | 71.89               | 0.43    | 71.13                             | 0.99    |
| English                                   | 92.00       | 3.88    | 70.18 *             | 0.71    | 74.73 *                           | 1.37    |
| Number of unique teachers                 | 98          |         | 6,826               |         | 2,411                             |         |
| Number of teacher/year obs                | 150         |         | 18,091              |         | 3,674                             |         |

\* Significantly different from TFA teachers at .05 level.

<sup>1</sup> Novice teachers are those with fewer than 3 years experience

<sup>2</sup> Based on Petersons College Selectivity Rankings

<sup>3</sup> There were 61 TFA teacher/year observations and 12,241 traditional teacher/year observations (2,214 novice) with valid PRAXIS scores. Scores are standardized onto the same scale across years.

<sup>4</sup> Science Licenses include: BIOLOGY (GRADES 9-12), CHEMISTRY (GRADES 9-12), EARTH SCIENCE (GRADES 9-12), PHYSICAL SCIENCE (GRADES 9-12), PHYSICS (GRADES 9-12), and SCIENCE (GRADES 9-12). Math licenses include MATHEMATICS (GRADES 9-12). English licenses include ENGLISH (GRADES 9-12) and READING (GRADES K-12).

<sup>5</sup> Science classes are Biology, Chemistry, Physical Science, and Physics. Math classes are Algebra I, Algebra II, and Geometry. English includes only English I.

Note: Population is limited to teachers who were positively matched to their students

Source: North Carolina Education Research Data Center



Table 2. Characteristics of classes taught by TFA and traditional high school teachers in North Carolina school districts that accepted TFA teachers: Year 2000-01 through 2006-07

|   | TFA teacher |         | Traditional teacher |         | Novice Trad. teacher <sup>1</sup> |         |
|---|-------------|---------|---------------------|---------|-----------------------------------|---------|
|   | Mean        | Std Err | Mean                | Std Err | Mean                              | Std Err |
| Average class size                            | 21.51       | 0.56    | 21.67               | 0.05    | 21.22                             | 0.10    |
| Percent minority                              | 80.93       | 0.99    | 47.81 *             | 0.13    | 52.67 *                           | 0.29    |
| Percent handicapped/learning disability       | 9.64        | 1.09    | 10.77               | 0.10    | 13.07 *                           | 0.25    |
| Percent LEP                                   | 2.62        | 0.36    | 2.82                | 0.04    | 3.20                              | 0.10    |
| Percent Male                                  | 47.70       | 0.79    | 50.77 *             | 0.07    | 51.78 *                           | 0.16    |
| <i>Percent achieving at level<sup>2</sup></i> |             |         |                     |         |                                   |         |
| Algebra I                                     |             |         |                     |         |                                   |         |
| Superior performance                          | 12.61       | 2.53    | 31.14 *             | 0.28    | 24.99 *                           | 0.54    |
| Consistent mastery                            | 46.24       | 3.83    | 37.27 *             | 0.20    | 38.65 *                           | 0.43    |
| Inconsistent mastery                          | 28.55       | 3.22    | 24.35               | 0.22    | 28.21                             | 0.49    |
| Insufficient mastery                          | 12.60       | 3.65    | 7.24                | 0.14    | 8.14                              | 0.32    |
| Algebra II                                    |             |         |                     |         |                                   |         |
| Superior performance                          | 11.44       | 2.09    | 34.61 *             | 0.38    | 27.90 *                           | 0.96    |
| Consistent mastery                            | 44.32       | 2.92    | 36.42 *             | 0.25    | 36.65 *                           | 0.61    |
| Inconsistent mastery                          | 36.96       | 3.23    | 24.73 *             | 0.30    | 29.95 *                           | 0.80    |
| Insufficient mastery                          | 7.28        | 1.79    | 4.23                | 0.13    | 5.50                              | 0.37    |
| Biology                                       |             |         |                     |         |                                   |         |
| Superior performance                          | 6.16        | 1.07    | 17.79 *             | 0.23    | 13.56 *                           | 0.44    |
| Consistent mastery                            | 37.05       | 2.01    | 40.69               | 0.22    | 38.45                             | 0.47    |
| Inconsistent mastery                          | 39.76       | 1.89    | 27.07 *             | 0.22    | 29.60 *                           | 0.46    |
| Insufficient mastery                          | 17.03       | 1.61    | 14.45               | 0.22    | 18.39                             | 0.54    |
| Chemistry                                     |             |         |                     |         |                                   |         |
| Superior performance                          | 14.88       | 2.30    | 32.27 *             | 0.43    | 22.16 *                           | 0.92    |
| Consistent mastery                            | 36.99       | 2.57    | 36.38               | 0.28    | 35.66                             | 0.68    |
| Inconsistent mastery                          | 36.35       | 2.88    | 21.83 *             | 0.29    | 28.00 *                           | 0.71    |
| Insufficient mastery                          | 11.79       | 1.76    | 9.52                | 0.24    | 14.18                             | 0.66    |
| Geometry                                      |             |         |                     |         |                                   |         |
| Superior performance                          | 5.89        | 1.38    | 24.99 *             | 0.33    | 20.51 *                           | 0.73    |
| Consistent mastery                            | 28.11       | 2.81    | 36.45 *             | 0.24    | 37.01 *                           | 0.55    |
| Inconsistent mastery                          | 48.27       | 2.97    | 30.84 *             | 0.28    | 33.44 *                           | 0.67    |
| Insufficient mastery                          | 17.73       | 2.86    | 7.72 *              | 0.16    | 9.05 *                            | 0.42    |
| Physics                                       |             |         |                     |         |                                   |         |
| Superior performance                          | 13.87       | 3.44    | 40.09 *             | 0.83    | 35.44 *                           | 2.38    |
| Consistent mastery                            | 50.77       | 5.83    | 40.20               | 0.60    | 43.85                             | 1.65    |
| Inconsistent mastery                          | 26.43       | 5.97    | 15.04               | 0.49    | 15.80                             | 1.37    |
| Insufficient mastery                          | 8.93        | 2.76    | 4.67                | 0.32    | 4.92                              | 0.73    |
| Physical science                              |             |         |                     |         |                                   |         |
| Superior performance                          | 6.55        | 2.47    | 13.01 *             | 0.31    | 11.37                             | 0.66    |
| Consistent mastery                            | 47.93       | 4.52    | 44.96               | 0.39    | 42.52                             | 0.91    |
| Inconsistent mastery                          | 42.83       | 5.71    | 33.61               | 0.41    | 35.69                             | 0.93    |
| Insufficient mastery                          | 2.69        | 1.22    | 8.43 *              | 0.29    | 10.43 *                           | 0.74    |
| English I                                     |             |         |                     |         |                                   |         |
| Superior performance                          | 12.50       | 1.33    | 30.21 *             | 0.28    | 26.82 *                           | 0.56    |
| Consistent mastery                            | 47.55       | 1.83    | 37.98 *             | 0.21    | 38.62 *                           | 0.44    |
| Inconsistent mastery                          | 29.86       | 1.58    | 21.89 *             | 0.21    | 23.90 *                           | 0.44    |
| Insufficient mastery                          | 10.09       | 1.18    | 9.92                | 0.18    | 10.66                             | 0.38    |
| Number of classes                             | 441         |         | 60,158              |         | 11,111                            |         |

\* Significantly different from TFA teachers at .05 level.

<sup>1</sup> Novice teachers are those with fewer than 3 years experience

<sup>2</sup> These are achievement levels defined by North Carolina Department of Public Instruction

Note: Population is limited to teachers who were positively matched to their students  
Source: North Carolina Education Research Data Center

Table 3. Characteristics of students taught by TFA and traditional high school teachers in North Carolina school districts that accepted TFA teachers: Year 2000-01 through 2006-07

|  | TFA teacher |         | Traditional teacher |         | Novice Trad. teacher <sup>1</sup> |         |
|--|-------------|---------|---------------------|---------|-----------------------------------|---------|
|  | Mean        | Std Err | Mean                | Std Err | Mean                              | Std Err |
| Sex (percent)                          |             |         |                     |         |                                   |         |
| Female                                 | 53.32       | 0.57    | 50.18 *             | 0.08    | 50.54 *                           | 0.12    |
| Male                                   | 46.68       | 0.57    | 49.82 *             | 0.08    | 49.46 *                           | 0.12    |
| Race (percent)                         |             |         |                     |         |                                   |         |
| Black                                  | 70.43       | 0.52    | 34.39 *             | 0.08    | 35.73 *                           | 0.12    |
| Hispanic                               | 4.03        | 0.22    | 5.84 *              | 0.04    | 5.77 *                            | 0.06    |
| White                                  | 21.62       | 0.47    | 54.23 *             | 0.08    | 53.05 *                           | 0.12    |
| Other                                  | 3.91        | 0.22    | 5.54 *              | 0.04    | 5.46 *                            | 0.06    |
| Exceptionality (percent)               |             |         |                     |         |                                   |         |
| Gifted                                 | 7.16        | 0.29    | 13.10 *             | 0.06    | 10.21 *                           | 0.08    |
| Learning disability                    | 4.25        | 0.23    | 4.52                | 0.04    | 4.53                              | 0.05    |
| Handicapped                            | 2.47        | 0.18    | 3.22 *              | 0.03    | 2.99 *                            | 0.04    |
| Non-exceptional                        | 86.11       | 0.39    | 73.94 *             | 0.07    | 76.08 *                           | 0.11    |
| LEP students (percent)                 |             |         |                     |         |                                   |         |
|  | 2.52        | 0.18    | 2.78                | 0.03    | 2.64                              | 0.04    |
| Parents' education attainment          |             |         |                     |         |                                   |         |
| Less than high school                  | 9.64        | 0.36    | 5.82 *              | 0.04    | 5.50 *                            | 0.06    |
| High school diploma                    | 31.91       | 0.57    | 19.42 *             | 0.07    | 19.11 *                           | 0.10    |
| Some college                           | 35.07       | 0.58    | 28.28 *             | 0.08    | 28.62 *                           | 0.12    |
| Bachelor's                             | 16.35       | 0.45    | 28.72 *             | 0.08    | 29.11 *                           | 0.12    |
| Graduate degree                        | 5.27        | 0.27    | 15.16 *             | 0.06    | 15.05 *                           | 0.09    |
| Achievement scores <sup>2</sup>        |             |         |                     |         |                                   |         |
| Algebra I                              | -0.40       | 0.03    | 0.03 *              | 0.00    | -0.16 *                           | 0.00    |
| Algebra II                             | -0.56       | 0.03    | 0.02 *              | 0.00    | -0.19 *                           | 0.01    |
| Biology                                | -0.48       | 0.02    | 0.04 *              | 0.00    | -0.13 *                           | 0.00    |
| Chemistry                              | -0.42       | 0.03    | 0.02 *              | 0.00    | -0.25 *                           | 0.01    |
| Geometry                               | -0.61       | 0.03    | 0.03 *              | 0.00    | -0.12 *                           | 0.01    |
| Physics                                | -0.68       | 0.05    | 0.00 *              | 0.01    | -0.10 *                           | 0.02    |
| Physical science                       | -0.27       | 0.06    | 0.02 *              | 0.00    | -0.11 *                           | 0.01    |
| English I                              | -0.55       | 0.02    | 0.04 *              | 0.00    | -0.06 *                           | 0.00    |
| Number of unique students <sup>3</sup> |             |         |                     |         |                                   |         |
|  | 7,691       |         | 350,678             |         | 161,644                           |         |

\* Significantly different from TFA teachers at .05 level.

<sup>1</sup> Novice teachers are those with fewer than 3 years experience

<sup>2</sup> Standardized scores by subject and year

<sup>3</sup> The total number of unique students in our sample is smaller than the sum of these numbers, as students may be taught by both TFA and traditional teachers

Note: Population is limited to teachers who were positively matched to their students and unique students

Source: North Carolina Education Research Data Center

Table 4. Student fixed-effects estimates, high school: Eight subjects including English I

| Independent variables                          | Without classroom vars |                | With classroom vars |                |
|--|------------------------|----------------|---------------------|----------------|
|  | Coef.                  | Std. Err.      | Coef.               | Std. Err.      |
| <b>TFA teacher</b> (ref: traditional teachers) | <b>0.097</b>           | <b>0.018 *</b> | <b>0.102</b>        | <b>0.018 *</b> |
| <i>Other Teacher characteristics</i>           |                        |                |                     |                |
| Teacher experience (ref: <3 yrs)               |                        |                |                     |                |
| 3 to 5 years                                   | 0.053                  | 0.006 *        | 0.049               | 0.006 *        |
| 6 to 10 years                                  | 0.053                  | 0.006 *        | 0.044               | 0.006 *        |
| 11 years or more                               | 0.051                  | 0.006 *        | 0.041               | 0.006 *        |
| Male (ref: female)                             | -0.064                 | 0.005 *        | -0.060              | 0.005 *        |
| Race (ref: other minorities)                   |                        |                |                     |                |
| Black  | -0.018                 | 0.021          | -0.011              | 0.020          |
| White  | 0.036                  | 0.020          | 0.034               | 0.020          |
| Hispanic                                       | -0.022                 | 0.029          | -0.016              | 0.028          |
| Education attainment (ref: BA)                 |                        |                |                     |                |
| Master's degree                                | -0.001                 | 0.005          | -0.003              | 0.005          |
| Doctorate/Other advanced degrees               | -0.036                 | 0.018 *        | -0.037              | 0.017 *        |
| <i>Classroom characteristics</i>               |                        |                |                     |                |
| Average grade-8 math                           |                        |                | 0.177               | 0.007 *        |
| Average grade-8 reading                        |                        |                | -0.022              | 0.007 *        |
| Class size                                     |                        |                | 0.000               | 0.000          |

\* Significant at level .05

Note: Included EOC subjects are: Algebra I, Algebra II, Biology, Chemistry, Geometry, Physics, Physical science and English I

All models include subject by grade fixed-effects as well as year fixed-effects.

Table 5. Student fixed-effects estimates, high school: Math subjects

| Independent variables                          | Without classroom vars |                | With classroom vars |                |
|--|------------------------|----------------|---------------------|----------------|
|  | Coef.                  | Std. Err.      | Coef.               | Std. Err.      |
| <b>TFA teacher</b> (ref: traditional teachers) | <b>0.104</b>           | <b>0.034 *</b> | <b>0.109</b>        | <b>0.034 *</b> |
| <i>Other Teacher characteristics</i>           |                        |                |                     |                |
| Teacher experience (ref: <3 yrs)               |                        |                |                     |                |
| 3 to 5 years                                   | 0.056                  | 0.007 *        | 0.053               | 0.007 *        |
| 6 to 10 years                                  | 0.057                  | 0.007 *        | 0.052               | 0.007 *        |
| 11 years or more                               | 0.056                  | 0.007 *        | 0.050               | 0.007 *        |
| Male (ref: female)                             | -0.062                 | 0.006 *        | -0.059              | 0.006 *        |
| Race (ref: other minorities)                   |                        |                |                     |                |
| Black  | 0.010                  | 0.018          | 0.015               | 0.018          |
| White  | 0.058                  | 0.017 *        | 0.057               | 0.017 *        |
| Hispanic                                       | 0.053                  | 0.032          | 0.058               | 0.032          |
| Education attainment (ref: BA)                 |                        |                |                     |                |
| Master's degree                                | 0.017                  | 0.007 *        | 0.016               | 0.006 *        |
| Doctorate/Other advanced degrees               | -0.039                 | 0.028          | -0.039              | 0.026          |
| <i>Classroom characteristics</i>               |                        |                |                     |                |
| Average grade-8 math                           |                        |                | 0.143               | 0.008 *        |
| Average grade-8 reading                        |                        |                | -0.061              | 0.009 *        |
| Class size                                     |                        |                | 0.000               | 0.000          |

\* Significant at level .05

Note: Included EOC subjects are: Algebra I, Algebra II and Geometry.

All models include subject by grade fixed-effects as well as year fixed-effects.

Table 6. Student fixed-effects estimates, high school: Science subjects

| Independent variables                          | Without classroom vars |                | With classroom vars |                |
|--|------------------------|----------------|---------------------|----------------|
|  | Coef.                  | Std. Err.      | Coef.               | Std. Err.      |
| <b>TFA teacher</b> (ref: traditional teachers) | <b>0.176</b>           | <b>0.032 *</b> | <b>0.181</b>        | <b>0.033 *</b> |
| <i>Other Teacher characteristics</i>           |                        |                |                     |                |
| Teacher experience (ref: <3 yrs)               |                        |                |                     |                |
| 3 to 5 years                                   | 0.068                  | 0.011 *        | 0.065               | 0.011 *        |
| 6 to 10 years                                  | 0.051                  | 0.012 *        | 0.045               | 0.012 *        |
| 11 years or more                               | 0.034                  | 0.010 *        | 0.027               | 0.010 *        |
| Male (ref: female)                             | -0.051                 | 0.009 *        | -0.049              | 0.009 *        |
| Race (ref: other minorities)                   |                        |                |                     |                |
| Black  | -0.075                 | 0.040          | -0.071              | 0.040          |
| White  | -0.029                 | 0.040          | -0.030              | 0.040          |
| Hispanic                                       | -0.102                 | 0.060          | -0.099              | 0.060          |
| Education attainment (ref: BA)                 |                        |                |                     |                |
| Master's degree                                | -0.009                 | 0.009          | -0.010              | 0.009          |
| Doctorate/Other advanced degrees               | -0.051                 | 0.019 *        | -0.051              | 0.019 *        |
| <i>Classroom characteristics</i>               |                        |                |                     |                |
| Average grade-8 math                           |                        |                | 0.114               | 0.011 *        |
| Average grade-8 reading                        |                        |                | -0.041              | 0.012 *        |
| Class size                                     |                        |                | 0.001               | 0.000 *        |

\* Significant at level .05

Note: Included EOC subjects are: Biology, Chemistry, Physics and Physical science

All models include subject by grade fixed-effects as well as year fixed-effects.

Table 7. Student fixed-effects estimates, high school: ID-matched teachers only

| Independent variables                          | All subjects |                | Math subjects |              | Science subjects |                |
|--|--------------|----------------|---------------|--------------|------------------|----------------|
|  | Coef.        | Std. Err.      | Coef.         | Std. Err.    | Coef.            | Std. Err.      |
| <b>TFA teacher</b> (ref: traditional teachers) | <b>0.140</b> | <b>0.024 *</b> | <b>0.059</b>  | <b>0.067</b> | <b>0.194</b>     | <b>0.042 *</b> |
| <i>Other Teacher characteristics</i>           |              |                |               |              |                  |                |
| Teacher experience (ref: <3 yrs)               |              |                |               |              |                  |                |
| 3 to 5 years                                   | 0.054        | 0.007 *        | 0.059         | 0.010 *      | 0.081            | 0.014 *        |
| 6 to 10 years                                  | 0.049        | 0.007 *        | 0.057         | 0.010 *      | 0.039            | 0.015 *        |
| 11 years or more                               | 0.042        | 0.007 *        | 0.050         | 0.009 *      | 0.032            | 0.013 *        |
| Male (ref: female)                             | -0.079       | 0.006 *        | -0.076        | 0.008 *      | -0.065           | 0.011 *        |
| Race (ref: other minorities)                   |              |                |               |              |                  |                |
| Black  | -0.017       | 0.028          | 0.024         | 0.030        | -0.113           | 0.053 *        |
| White  | 0.046        | 0.027          | 0.089         | 0.027 *      | -0.059           | 0.050          |
| Hispanic                                       | -0.036       | 0.040          | 0.112         | 0.049 *      | -0.228           | 0.077 *        |
| Education attainment (ref: BA)                 |              |                |               |              |                  |                |
| Master's degree                                | -0.003       | 0.006          | 0.015         | 0.009        | 0.002            | 0.011          |
| Doctorate/Other advanced degrees               | -0.049       | 0.023 *        | -0.015        | 0.037        | -0.054           | 0.027 *        |
| <i>Classroom characteristics</i>               |              |                |               |              |                  |                |
| Average grade-8 math                           | 0.191        | 0.008 *        | 0.159         | 0.011 *      | 0.133            | 0.016 *        |
| Average grade-8 reading                        | -0.041       | 0.009 *        | -0.085        | 0.013 *      | -0.055           | 0.018 *        |
| Class size                                     | 0.000        | 0.000 *        | 0.001         | 0.000 *      | 0.001            | 0.000 *        |

\* Significant at level .05

Note: Included EOC subjects are: Algebra I, Algebra II, Biology, Chemistry, Geometry, Physics, Physical science and English I

All models include subject by grade fixed-effects as well as year fixed-effects.

Table 8. Student fixed-effects estimates, high school: TFA vs in-field traditional teachers

| Independent variables                          | All subjects |                | Math subjects |                | Science subjects |                |
|--|--------------|----------------|---------------|----------------|------------------|----------------|
|  | Coef.        | Std. Err.      | Coef.         | Std. Err.      | Coef.            | Std. Err.      |
| <b>TFA teacher</b> (ref: traditional teachers) | <b>0.106</b> | <b>0.018 *</b> | <b>0.099</b>  | <b>0.037 *</b> | <b>0.180</b>     | <b>0.032 *</b> |
| <i>Other Teacher characteristics</i>           |              |                |               |                |                  |                |
| Teacher experience (ref: <3 yrs)               |              |                |               |                |                  |                |
| 3 to 5 years                                   | 0.051        | 0.006 *        | 0.056         | 0.008 *        | 0.060            | 0.011 *        |
| 6 to 10 years                                  | 0.049        | 0.006 *        | 0.056         | 0.007 *        | 0.044            | 0.012 *        |
| 11 years or more                               | 0.040        | 0.006 *        | 0.050         | 0.007 *        | 0.025            | 0.010 *        |
| Male (ref: female)                             | -0.061       | 0.006 *        | -0.060        | 0.007 *        | -0.054           | 0.009 *        |
| Race (ref: other minorities)                   |              |                |               |                |                  |                |
| Black  | -0.023       | 0.022          | 0.000         | 0.019          | -0.062           | 0.041          |
| White  | 0.018        | 0.022          | 0.033         | 0.017          | -0.024           | 0.041          |
| Hispanic                                       | -0.027       | 0.030          | 0.044         | 0.031          | -0.084           | 0.061          |
| Education attainment (ref: BA)                 |              |                |               |                |                  |                |
| Master's degree                                | -0.007       | 0.006          | 0.010         | 0.007          | -0.011           | 0.009          |
| Doctorate/Other advanced degrees               | -0.042       | 0.018 *        | -0.011        | 0.035          | -0.052           | 0.019 *        |
| <i>Classroom characteristics</i>               |              |                |               |                |                  |                |
| Average grade-8 math                           | 0.179        | 0.007 *        | 0.098         | 0.009 *        | 0.119            | 0.012 *        |
| Average grade-8 reading                        | -0.025       | 0.007 *        | -0.013        | 0.010          | -0.046           | 0.013 *        |
| Class size                                     | 0.000        | 0.000          | 0.000         | 0.000          | 0.001            | 0.000 *        |

\* Significant at level .05

Note: Included EOC subjects are: Algebra I, Algebra II, Biology, Chemistry, Geometry, Physics and Physical science

All models include subject by grade fixed-effects as well as year fixed-effects.



Table 9. Student fixed-effects estimates, high school: TFA vs SP1 traditional teachers

| Independent variables                          | All subjects |                | Math subjects |                | Science subjects |                |
|--|--------------|----------------|---------------|----------------|------------------|----------------|
|  | Coef.        | Std. Err.      | Coef.         | Std. Err.      | Coef.            | Std. Err.      |
| <b>TFA teacher</b> (ref: traditional teachers) | <b>0.131</b> | <b>0.021 *</b> | <b>0.163</b>  | <b>0.058 *</b> | <b>0.157</b>     | <b>0.057 *</b> |
| <i>Other Teacher characteristics</i>           |              |                |               |                |                  |                |
| Teacher experience (ref: <3 yrs)               |              |                |               |                |                  |                |
| 3 to 5 years                                   | 0.028        | 0.014 *        | -0.008        | 0.035          | 0.150            | 0.039 *        |
| 6 to 10 years                                  | -0.025       | 0.018          | -0.020        | 0.040          | 0.045            | 0.043          |
| 11 years or more                               | -0.074       | 0.026 *        | 0.042         | 0.036          | -0.201           | 0.051 *        |
| Male (ref: female)                             | -0.013       | 0.011          | -0.036        | 0.021          | 0.022            | 0.033          |
| Race (ref: other minorities)                   |              |                |               |                |                  |                |
| Black  | -0.075       | 0.035 *        | -0.154        | 0.064 *        | -0.189           | 0.106          |
| White  | -0.021       | 0.034          | -0.057        | 0.059          | -0.230           | 0.092 *        |
| Hispanic                                       | 0.029        | 0.045          | 0.067         | 0.081          | -0.037           | 0.108          |
| Education attainment (ref: BA)                 |              |                |               |                |                  |                |
| Master's degree                                | 0.011        | 0.012          | -0.003        | 0.025          | 0.126            | 0.037 *        |
| Doctorate/Other advanced degrees               | 0.039        | 0.040          | -0.212        | 0.063 *        | 0.175            | 0.055 *        |
| <i>Classroom characteristics</i>               |              |                |               |                |                  |                |
| Average grade-8 math                           | 0.134        | 0.022 *        | 0.026         | 0.045          | 0.204            | 0.064 *        |
| Average grade-8 reading                        | 0.027        | 0.023          | 0.074         | 0.049          | -0.189           | 0.070 *        |
| Class size                                     | -0.001       | 0.000          | -0.001        | 0.001          | 0.002            | 0.001          |

\* Significant at level .05

Note: Included EOC subjects are: Algebra I, Algebra II, Biology, Chemistry, Geometry, Physics and Physical science  
All models include subject by grade fixed-effects as well as year fixed-effects.

Table 10. Student fixed-effects estimates, high school: TFA vs SP2 traditional teachers, by subject areas

| Independent variables                          | All subjects |                | Math subjects |              | Science subjects |                |
|--|--------------|----------------|---------------|--------------|------------------|----------------|
|  | Coef.        | Std. Err.      | Coef.         | Std. Err.    | Coef.            | Std. Err.      |
| <b>TFA teacher</b> (ref: traditional teachers) | <b>0.051</b> | <b>0.019 *</b> | <b>0.049</b>  | <b>0.037</b> | <b>0.128</b>     | <b>0.042 *</b> |
| <i>Other Teacher characteristics</i>           |              |                |               |              |                  |                |
| Teacher experience (ref: <3 yrs)               |              |                |               |              |                  |                |
| 3 to 5 years                                   | 0.014        | 0.007          | 0.006         | 0.010        | 0.017            | 0.014          |
| 6 to 10 years                                  | 0.004        | 0.008          | 0.002         | 0.010        | -0.009           | 0.016          |
| 11 years or more                               | -0.002       | 0.008          | -0.003        | 0.010        | -0.027           | 0.015          |
| Male (ref: female)                             | -0.064       | 0.006 *        | -0.066        | 0.007 *      | -0.050           | 0.011 *        |
| Race (ref: other minorities)                   |              |                |               |              |                  |                |
| Black  | -0.019       | 0.031          | 0.040         | 0.021        | -0.094           | 0.069          |
| White  | 0.025        | 0.030          | 0.079         | 0.020 *      | -0.062           | 0.068          |
| Hispanic                                       | -0.070       | 0.039          | 0.044         | 0.055        | -0.308           | 0.076 *        |
| Education attainment (ref: BA)                 |              |                |               |              |                  |                |
| Master's degree                                | -0.004       | 0.006          | 0.013         | 0.007        | -0.014           | 0.010          |
| Doctorate/Other advanced degrees               | -0.022       | 0.019          | -0.003        | 0.032        | -0.042           | 0.023          |
| <i>Classroom characteristics</i>               |              |                |               |              |                  |                |
| Peer average achievement                       | 0.184        | 0.007 *        | 0.156         | 0.010 *      | 0.111            | 0.014 *        |
| Class size                                     | -0.029       | 0.008 *        | -0.077        | 0.011 *      | -0.039           | 0.015 *        |
| Class size                                     | 0.000        | 0.000          | 0.000         | 0.000        | 0.001            | 0.000 *        |

\* Significant at level .05

Note: Included EOC subjects are: Algebra I, Algebra II, and Geometry

All models include subject by grade fixed-effects as well as year fixed-effects.

Table 11. Student fixed-effects estimates, high school: TFA vs traditional track teachers

| Independent variables                          | All subjects |                | Math subjects |              | Science subjects |                |
|--|--------------|----------------|---------------|--------------|------------------|----------------|
|  | Coef.        | Std. Err.      | Coef.         | Std. Err.    | Coef.            | Std. Err.      |
| <b>TFA teacher</b> (ref: traditional teachers) | <b>0.094</b> | <b>0.021 *</b> | <b>0.075</b>  | <b>0.041</b> | <b>0.157</b>     | <b>0.048 *</b> |
| <i>Other Teacher characteristics</i>           |              |                |               |              |                  |                |
| Teacher experience (ref: <3 yrs)               |              |                |               |              |                  |                |
| 3 to 5 years                                   | 0.032        | 0.008 *        | 0.031         | 0.012 *      | 0.008            | 0.017          |
| 6 to 10 years                                  | 0.014        | 0.008          | 0.022         | 0.011 *      | -0.033           | 0.018          |
| 11 years or more                               | 0.020        | 0.008 *        | 0.029         | 0.011 *      | -0.004           | 0.016          |
| Male (ref: female)                             | -0.062       | 0.007 *        | -0.067        | 0.009 *      | -0.048           | 0.015 *        |
| Race (ref: other minorities)                   |              |                |               |              |                  |                |
| Black  | -0.045       | 0.034          | 0.106         | 0.027 *      | -0.170           | 0.068 *        |
| White  | 0.001        | 0.033          | 0.130         | 0.026 *      | -0.140           | 0.061 *        |
| Hispanic                                       | -0.076       | 0.053          | 0.147         | 0.041 *      | 0.053            | 0.106          |
| Education attainment (ref: BA)                 |              |                |               |              |                  |                |
| Master's degree                                | 0.002        | 0.007          | 0.019         | 0.009 *      | -0.017           | 0.013          |
| Doctorate/Other advanced degrees               | 0.030        | 0.027          | 0.034         | 0.048        | 0.026            | 0.030          |
| <i>Classroom characteristics</i>               |              |                |               |              |                  |                |
| Average grade-8 math                           | 0.178        | 0.009 *        | 0.150         | 0.012 *      | 0.113            | 0.019 *        |
| Average grade-8 reading                        | -0.028       | 0.009 *        | -0.066        | 0.014 *      | -0.038           | 0.020          |
| Class size                                     | 0.000        | 0.000          | 0.000         | 0.000        | 0.001            | 0.000 *        |

\* Significant at level .05

Note: Included EOC subjects are: Algebra I, Algebra II, Biology, Chemistry, Geometry, Physics and Physical science  
 All models include subject by grade fixed-effects as well as year fixed-effects.

Table 12. Student fixed-effects estimates, high school: by performance quartiles

| Independent variables                          | Top quarter  |                | Bottom quarter |                | Middle 2 quarters |                |
|--|--------------|----------------|----------------|----------------|-------------------|----------------|
|  | Coef.        | Std. Err.      | Coef.          | Std. Err.      | Coef.             | Std. Err.      |
| <b>TFA teacher</b> (ref: traditional teachers) | <b>0.138</b> | <b>0.041 *</b> | <b>0.061</b>   | <b>0.017 *</b> | <b>0.091</b>      | <b>0.023 *</b> |
| <i>Other Teacher characteristics</i>           |              |                |                |                |                   |                |
| Teacher experience (ref: <3 yrs)               |              |                |                |                |                   |                |
| 3 to 5 years                                   | 0.040        | 0.008 *        | 0.054          | 0.007 *        | 0.047             | 0.006 *        |
| 6 to 10 years                                  | 0.038        | 0.009 *        | 0.039          | 0.007 *        | 0.049             | 0.007 *        |
| 11 years or more                               | 0.031        | 0.008 *        | 0.032          | 0.006 *        | 0.040             | 0.006 *        |
| Male (ref: female)                             | -0.063       | 0.008 *        | -0.035         | 0.006 *        | -0.059            | 0.006 *        |
| Race (ref: other minorities)                   |              |                |                |                |                   |                |
| Black  | -0.062       | 0.038          | -0.015         | 0.016          | 0.006             | 0.020          |
| White  | 0.031        | 0.037          | 0.001          | 0.015          | 0.045             | 0.019 *        |
| Hispanic                                       | -0.027       | 0.054          | -0.014         | 0.030          | 0.017             | 0.032          |
| Education attainment (ref: BA)                 |              |                |                |                |                   |                |
| Master's degree                                | 0.007        | 0.007          | -0.004         | 0.005          | -0.003            | 0.005          |
| Doctorate/Other advanced degrees               | -0.029       | 0.022          | -0.063         | 0.017 *        | -0.036            | 0.020          |
| <i>Classroom characteristics</i>               |              |                |                |                |                   |                |
| Average grade-8 math                           | 0.241        | 0.012 *        | 0.053          | 0.009 *        | 0.156             | 0.008 *        |
| Average grade-8 reading                        | -0.098       | 0.014 *        | 0.096          | 0.009 *        | 0.008             | 0.009          |
| Class size                                     | 0.001        | 0.000 *        | 0.000          | 0.000          | 0.000             | 0.000          |

\* Significant at level .05

Note: Included EOC subjects are: Algebra I, Algebra II, Biology, Chemistry, Geometry, Physics, Physical science, and Eng I. Performance quartiles are defined on student mean scores across subjects.

All models include subject by grade fixed-effects as well as year fixed-effects.

